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CHEMISTRY AND THE FUTURE

By Professor HAROLD C. UREY

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IN discussing any subject which deals with an extrapolation from the past to the future, one can not make any certain or dogmatic statements. In the physical sciences extrapolations are very likely to be incorrect even when they involve only a small percentage of the region covered by reliable data unless a very fundamental theory of the phenomena based upon broad scientific evidence exists. Such conditions do not obtain with regard to my subject, and I can not risk more than the most general predictions in regard to the future. Moreover, these general predictions must be predicated upon several alternatives which are definitely beyond the control of chemists or scientists, and which are vital to their future.

It is necessary, in the first place, to consider the objectives of two groups of people. The first of these is the scientific group, and the second is the group consisting of the community as a whole. In neither case are the objectives exactly formulated, though it seems to me that those of the scientific group are more definite than those of the community in which we work. Of course, the objectives for all chemists or all scientists are not the same, but there is a very considerable agreement between these individuals. The people of the community, on the other hand, are swayed by so many emotions that these appear to be the most unpredictable quantity in the entire problem.

Scientific men are those who are posing particular questions to nature and its laws as they operate about us. In doing so they arrange most carefully devised experiments to test whether the ideas which they have in regard to the operation of natural law are in fact in accordance with these laws. If their postulates are not correct, the answer which they receive is an em-

phatic negative, and nature resists all efforts to impose erroneous ideas upon her. But if their postulates are in accordance with what we call natural law, nature unlocks her secrets with an amazing ease. When this occurs there is a communion between scientists and the eternal laws governing the behavior of this universe that is very intimate indeed. This communion represents the highest reward which a scientist receives for his services, and it is this that furnishes the major driving force for all his activities.[1]

A secondary objective of his activities is also important. Experience has shown that this understanding of nature's laws makes it possible for man to improve his physical well-being by adapting them to his own purposes. No matter where we work in our university or industrial laboratories, whether upon purely intellectual pursuits in connection with scientific things or upon the immediate use of these laws of nature, we all have in mind this second objective. We desire that the things that we do shall at some time and somewhere be of use to our fellow men in their physical and intellectual pursuits.

On the other hand, the divergence of the objectives of the people of the community, as shown by current activities, is truly amazing. There are extensive organizations of men whose activities if successful would make man supremely wealthy, would bring him dire poverty, would make him well informed even if not more intelligent, reduce him to the ignorance of dumb beasts, would destroy not only his home and useful material things, but would waste and destroy the sources of this wealth. As one watches to-day and attempts to see what chemistry or its sister sciences will do in the future, one can only feel that his own and all other prophecies are mere guesses without even an estimate of the probable errors. I can not say what it is that man really desires. In fact, it is not the desires of any localized group, but very largely the desires of men in the entire world that are important in this connection, for those in any one part of it may be forced to do things which they do not desire, because of the activities of others. I can only contribute to this discussion by pointing out some things which can be aided by chemistry if certain objectives are desired.

In the first place, chemistry can and perhaps will destroy our European civilization. In the efficient destructive machines which are in use to-day the most important agent is a chemical substance, an explosive, an incendiary mixture or a poison gas. All the other scientific contributions to these machines are to make this distinctly chemical contribution effective. The last great war demonstrated that these destructive methods can destroy the wealth of countries to such an extent that many years are required to even partially recuperate, and as a secondary result they can damage governmental régimes beyond repair and can make a world less safe for democracy or anything else. It appears to-day that even greater effects will result from another such war, and I do not believe that it is too much to say that a complete destruction of our civilization may result from such a war. The most crucial requirements for such conflict are chemical in nature. The secondary materials required for the support of armies and their movements are also to an important extent chemical in nature and greatly dependent on chemical industries. Liquid fuel is vital to the transportation of armies at the present time, and in addition chemistry contributes to nearly all the materials used in a modern war, as well as in peace. If the people of the world desire to make war chemistry will aid them. It will destroy people, their material possessions, and will dissipate and destroy the resources of the earth.

A very different future of chemistry can be painted if people so desire. If chemistry is permitted to devote its energies to peaceful pursuits, an abundance of goods valuable to man can be produced, and in addition it can contribute, together with its sister sciences, to man's knowledge of the universe and his place in it. It will help to free him from superstition and error, and will bring him intellectual pleasure.

In the past many of our sister sciences have contributed notably to the broadening of man's intellectual horizon. Astronomy gave him a proper perspective of his own importance and his own position in this universe. His earth is not the center of the solar system, nor is his solar system the center of this galaxy. At the same time that he was robbed of his central position in the physical universe what a grandeur has been spread before him as our knowledge of astronomy grows! Biology has robbed him of his miraculous creation by one or another anthropomorphic god, and has placed him in the lowly position of one of the animals, that one, in fact, who in this particular geological age dominates the earth, but at the same time the grandeur of an organic evolution with time has been spread before him. Geology has shown him the long length of time that man and his lowly ancestors have existed on this planet, and in fact that life on this planet has been nearly coexistent with the planet. Chemistry up to the present time can claim no such important contributions to man's understanding about himself. People have had no previous conceptions of the structure of matter either erroneous or otherwise, and thus the atomic theory has not driven clouds of superstition

[1] R. S. Mulliken (SCIENCE, 86: 65–68, 1937), has given an excellent discussion on the methods and objectives of scientists.

away. No traditions or prejudices have prevented us from manufacturing soap and sulfuric acid, or even synthetizing such things as sex hormones, and thus chemistry has operated during the past years with great freedom and with little opposition from our fellow men. Chemistry is, however, perhaps contributing to the present situation which has stimulated conferences of this sort. During the last century, and particularly the years of the twentieth century, chemistry and the other sciences have greatly increased our productive capacity. This productive capacity has been increased beyond anything which the world has previously seen, and promises to greatly increase it in the future. At the present time this development is probably causing the enormous social change which we who are here can not see in the proper perspective because we are a part of the phenomena. It seems to me that there is little doubt but what much of the unrest of the civilized world for the past twenty-five years, resulting in revolutions, new systems of governments and world-wide depression, is all rather closely related to this productive capacity largely brought about by science. This has been recognized by others and the suggestion has been made that the proper cure of these things is to artificially decrease our ability to produce. This is a cowardly point of view. In spite of all the many perturbing events which have arisen, it seems to me, as a result of this important change, we should look forward to the future with the greatest hope. If we act with courage our descendants will live in an abundance of necessities and luxuries the like of which we can not imagine. If we are not courageous, they may live with less than we have at present.

Chemistry is a study of the substances which we find about us. From the materialistic side chemistry can supply materials in abundance and in great variety. Most of the materials used in all construction to-day, with the exception of wood, are the product of chemistry, and wood as it is used is improved and preserved in many cases by the use of chemicals. Metallurgy is essentially a branch of chemistry, dealing with the preparation and the utilization of metals. Just how much of such materials are supplied in the future is not a matter of chemistry, but one of social organization. We have laboratories and men to produce all that can be accepted by industry at the present time, and we can train the necessary men and build and equip all laboratories needed in the future. The cost of chemical research, and, in fact, of all research, is but a very small fraction of the production costs, and the result pays most handsome dividends in new materials and new processes.

Without in any way wishing to place blame, we may note that since the world war no country has arranged its internal affairs in such a way that anything approaching the maximum production of material goods for peaceful purposes has been accomplished. Among the large countries Russia only has stated that her objective was the production of goods for use. Due to a mistake in political philosophy, inadequate numbers of properly trained men and the necessity of defending two borders some six thousand miles apart against threats of invasion, her achievements have not been satisfactory. England, with a correct political philosophy, with a remarkable mineral wealth and being the home country of a friendly commonwealth of nations, has not succeeded in this respect, as any one can see who travels in England and who observes the amount spent on the dole, and has sufficient imagination to think of living on its stipend. Germany, with another political philosophy, has definitely decided in favor of guns rather than butter, and in addition has a definite lack of natural resources and apparently lacks the bargaining ability to secure them. The United States and Canada have succeeded better than any other country, due undoubtedly to a correct political philosophy, adequate resources, adequately trained men and freedom from threats of invasion. We desire peace, and we have a desire for the good things which science and technology can bring. There was, however, some fatal defect which caused an increasing unemployment which led to the break in 1929, and our inability since then to get this production machinery going again. The average for the years since the world war for all the people of these two countries has not been satisfactory. Other countries could be reviewed, but the story is so similar as to be monotonous. Perhaps the Scandinavian countries have done as well as or better than any in this respect, but they are not easily compared with the larger units which I have just mentioned. Perhaps the correctness or incorrectness of the political philosophy is important, but I think that it is impossible to see clearly that such is the case from the examples that we have considered so far.

Our people wish those things which chemistry can bring to them, but for some reason our chemical plants are partly idle, our chemists unemployed, and our workmen are on some form of direct or indirect relief. This is the problem of the future of chemistry which does not yield to chemical methods of solution, and without its solution it is only possible to express hopes for the future.

Since the beginning of scientific chemistry some 150 or 200 years ago there has been an accelerated rate with which our scientific discovery and invention has taken place. At the beginning of the nineteenth century Dalton proposed the atomic theory, which has dominated all chemical theory and experiments since

then. During the century, 34 chemical elements were discovered, bringing the total known elements to 81. The chemical properties, methods of preparation and analysis of the elements and their compounds were extensively studied. The system of classification of the chemical elements known as the periodic system was discovered. The extensive chemistry of the compounds of carbon and the syntheses of compounds occurring in natural products were begun and greatly advanced during the century. The fundamental laws of thermodynamics were proposed and the beginning made of their application to chemical problems. The foundations of statistical mechanics which have been used recently in the understanding of chemical problems were laid in that century. In addition to the old chemical processes, such as the limited manufacture of soda and mineral acids, this century saw the beginning of the extensive manufacture of coal-tar dyes and the use of petroleum. The growth of chemistry during the century was so great that in 1900 one might wonder what was yet to be done, and yet growth since 1900 has been so great that one naturally feels that very little was known at that time.

I wish to illustrate the growth of this science since 1900 by giving a partial list of the important discoveries made since then. I am including in this table some things which perhaps belong rather in the field of physics because they have contributed in such an outstanding way to the science of chemistry.

1899	Discovery of the quantum theory by Planck
1901	Synthesis of polypeptides—E. Fischer
1902	Hydrogenation of fats—Normann
1905–1913	Development of the Haber process
1906	Third law of thermodynamics—Nernst
1872–1908	Bakelite—first of important plastics
1911	Nuclear atom—Rutherford
1911	Discovery of isotopes—Fajans and Soddy
1912	Diffraction of x-rays and crystal structure—v. Laue and Bragg
1912	Preparation of pure anthocyanines—Willstätter
1913	Quantum theory of the atom—Bohr
1916–1938	Structure of monomolecular films—Langmuir
1919	First transmutation—Rutherford
1920–1930	Rapid development of rayon manufacture
1920–1938	Chemistry of sterols, bile acids and sex hormones—Windaus, Ruzicka, Karrer and others
1921	Discovery of insulin—Banting
1923	Debye-Hückel theory of electrolytes
1923	Ultracentrifuge and molecular weights of biochemical substances—Svedberg
1926	Attainment of very low temperatures by magnetic methods—Giauque and Debye
1926	The exact quantum theory—de Broglie, Heisenberg, Schrödinger, Dirac
1926	Constitution and synthesis of thyroxin—Harrington
1926	Isolation of vitamin B_1 in crystalline form—Jensen and Donath
1926	Preparation of vitamin D by irradiation of ergosterol—Windaus and Pohl, Rosenheim and Hess
1927–1938	Theory of valence—Heitler, London, Slater, Pauling, Mulliken
1927	Isolation of vitamin C—Szent-Györgyi
1927	Application of quantum theory to kinetics of reactions—Polanyi, Eyring
1929	Synthesis of porphyrins—Hans Fischer
1930–1938	Crystallization of enzymes—Sumner, Northrup
1931	Deuterium—Urey
1931	Synthetic rubber
1931	Constitution of carotinoids and vitamin A—Karrer
1932	Discovery of Flavin enzymes—Warburg
1933	The constitution of coferments
1934	Artificial radioactivity—F. and I. Joliot-Curie
1935	Isolation of the tobacco leaf mosaic virus protein—Stanley

There are three main developments which are worthy of discussion in regard to the development of the last thirty-eight years. These are:

(1) The development of our understanding of the structure of atoms and molecules, and the application of this knowledge to an understanding of chemical reactions.

(2) The development of the field of biochemistry, which has concerned itself with the isolation and synthesis of compounds occurring in living organisms and with their physiological effects and applications to medicine and hygiene, and

(3) The development of one of the largest modern industries, namely the chemical industry with its many ramifications.

Other important developments represented in this list not included in the three items that I have just mentioned are the Debye-Hückel theory of electrolytes, the discovery of monolayers by Langmuir and others, and the discovery of artificial radioactivity and its important effect upon chemical research.

In the very closing years of the nineteenth century Planck announced his first postulates of the quantum theory, and this theory has dominated the developments of physical science during this century in much the same way that Dalton's atomic theory dominated the chemistry of the nineteenth century. Parallel with this development and within a few years of its first proposal, radioactivity was discovered, which led to an understanding of the structure of the atom. Rutherford recognized the essential character of the structure of atoms as the result of the use of the projectiles spontaneously emitted from radioactive substances.

The study of radioactive substances led to the discovery of isotopes. X-rays, discovered within a year or so of the discovery of radioactivity, have unlocked the structure of crystals and have given us the means of measuring the distances between atoms in solids and in liquids. Bohr's theory of the atom combined Rutherford's work on the nuclear atom with Planck's quantum theory and gave us our first explanation of the thousands of wave-lengths of light emitted by atoms, and finally led to the exact statement of the quantum theory by de Broglie, Heisenberg, Schrödinger and Dirac, and from this follows an understanding of the valence forces between atoms and compounds and the velocity of chemical reactions.

Much of the biochemical work has been concerned with an understanding of protein substances, the understanding of chlorophyl and haemoglobin, the isolation of enzymes, hormones and vitamins and their syntheses. This information is particularly useful, not quite from the standpoint of medicine exactly, but more from the standpoint of avoiding in many cases the necessity for medicine, for, after all, medicines are in many ways foreign substances to living organisms. By understanding the hormones secreted by the internal glands of animals and the vitamins which we secure from foods, man in the future can be kept well rather than cured of disease. The work which I have included in this list at this time has been done principally with the object of understanding the fundamentals of biochemistry, that is, the chemistry of living things. Their use in this way is a by-product of this activity.

I have also included in the list some of the industrial processes. The hydrogenation of fats makes it possible to secure large amounts of solid fats from such cheap substances as cotton seed oil. The Haber process for the manufacture of ammonia enabled Germany to hold out against great odds in the world war. I think there can be little doubt but what Haber was the most important single individual in Germany so far as the prosecution of her war was concerned. It is interesting indeed that he was exiled by his own country in 1933 and was welcomed by his enemy, England.

Bakelite was the first of the important synthetic plastics which is now used for so much of our electrical insulation. The success of this plastic also led to the development of many others since then. The development of the modern lacquer industry is closely related to this. So many objects to-day are protected by a thin film of what is essentially cellulose, together with pigments of all brilliant colors. The manufacture of rayon greatly increased during the decade from 1920–1930, though the essentials of the process were discovered during the nineteenth century. Its successful commercial exploitation has only been possible in recent years.

In 1931 synthetic rubber was produced. This can not be produced in competition with natural rubber, but the synthetic variety has desirable properties not possessed by natural rubber. There are so many chemical processes which have been developed during this century that it is difficult to select even a few for special mention. One might mention the recovery of bromine from sea water as carried out by the Dow Chemical Company. This bromine is mostly used in the manufacture of ethylene bromide and together with lead tetraethyl is added to our gasoline. Of course, one is immediately reminded at this point that the development of gasoline is an enormous business in itself. We must immediately think of cracking processes, hydrogenation processes, processes for the recovery of natural gas, the manufacture of lubricating oils, the hydrogenation of coal, etc. It is only necessary to mention stainless steel for one to realize the great revolution in metals that has taken place in this century, for stainless steel is only one of many varieties of alloys which have found their place in modern industry. How important the whole field of detergents is! One should not forget to mention dyes, which in dollars and cents are in a way quite unimportant but which beautify our clothes, our homes and practically all articles that we use. The cost of these brilliant colors has been reduced until the poorest of the population are arrayed in colors that only the most wealthy could have afforded even so short a time ago as one century. So many of these processes of industrial chemistry are so commonplace that we fail to recall that they have not always existed. Many of them have existed only a matter of years, and a large percentage of them only a matter of decades.

The list of the important contributions which I have presented can not be extrapolated to the future. If I could make a reasonable estimate of what the next great development would be, that would be a very important step in making the next discovery. One can not predict the discovery of the Haber process or insulin or artificial radioactivity before they occur, for the reason that these are such new and outstanding things that before their discovery no one had the slightest idea that they existed. I can only point the trend. During the last twenty years the organic chemistry of products produced by living organisms has shown a remarkable growth. Vitamins, hormones, enzymes, have been discovered and isolated. Proteins have been crystalized, and, in fact, one, the tobacco leaf mosaic, appears to be a dead protein which can cause a disease and multiply itself, thus in a way bridging the living and the inanimate. This field will certainly develop markedly in the next years. In the second place, there is a marked trend toward the understanding of the fundamentals of chemical behavior. Nernst stated the third law of thermodynamics in 1906, but to-day,

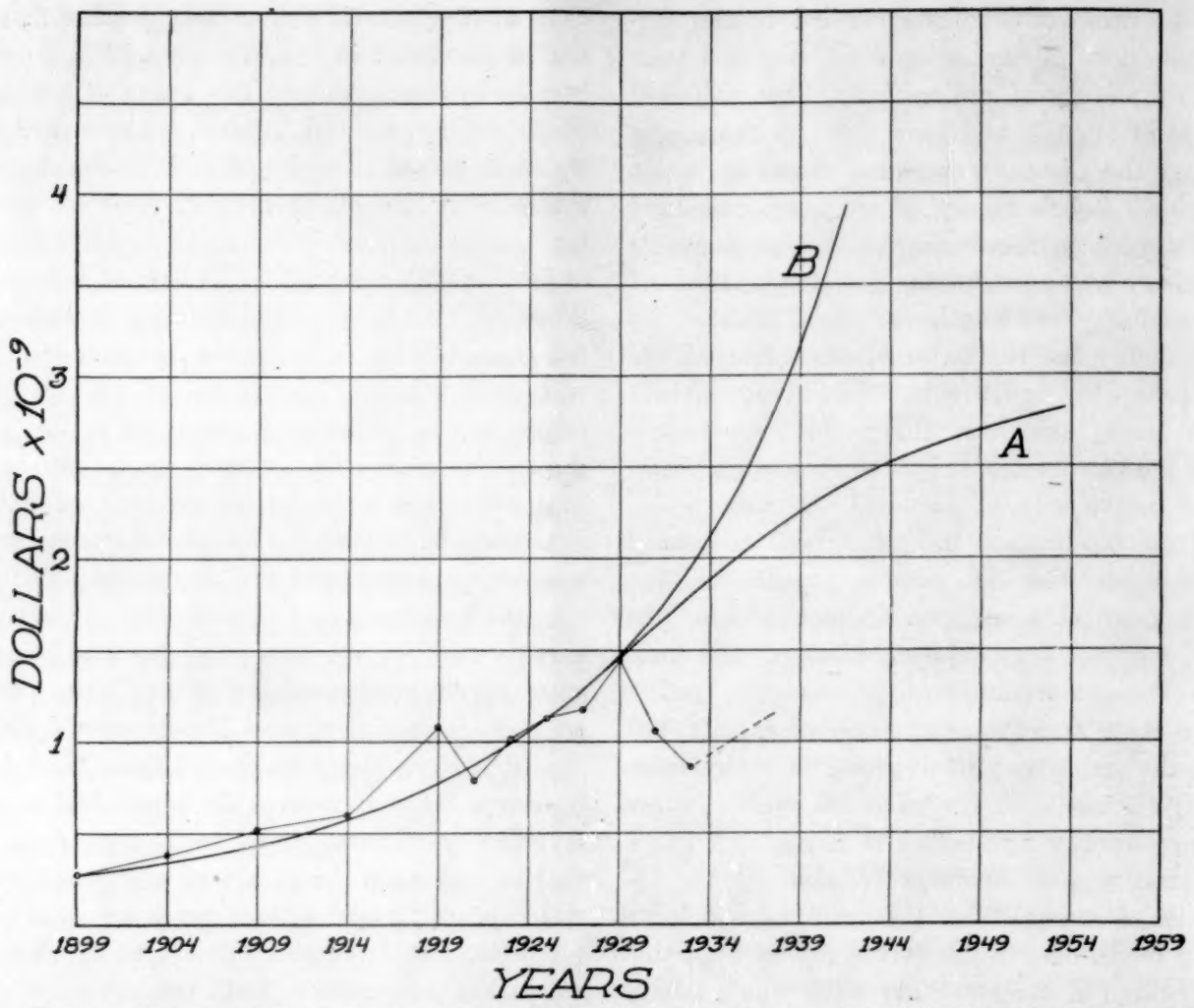


FIG. 1. Value added by chemical and allied industries to raw materials in the United States. Compiled from the Biennial Census of Manufactures, U. S. Dept. of Commerce.

together with the quantum theory, we have far more exact understanding of that law than ever before. It is being applied to chemical reactions of considerable complexity with confidence and enables us to understand far better the fundamentals of our chemistry. The new artificial radioactivity and the great activity in physics in this connection are important developments for chemical research. In the industrial field straight through the depression the number of useful products has been increased in many ways.

To show the possible future industrial development I can best use a plot showing the value of chemical products produced as a function of time in the past. The plot shown in Fig. 1 is constructed from data for the United States. This is probably one of the best countries to select for our present purposes because its industry was disturbed less by the war than most others and because there has been no change in political institutions since 1900, and, finally because it is such a large industrial country that most processes and products will be adequately represented. This shows a plot of the value of chemical products in current dollars against years. No attempt has been made to correct the dollars for the gradual depreciation of the dollar which has occurred over that time. The solid curve shows the approximate course from 1900 to 1929, and an extrapolated curve, A, beyond that time, which one might have expected the industry to follow had the 1929 catastrophe not occurred. The curve is of the usual kind characteristic of industries, grows rapidly for a while and then gradually flattens out. Further growth can not be expected unless some very marked rejuvenation occurs. The figure makes evident the fact that from 1929 to the present the production did not increase as would be expected from this curve. I leave the question of the 1929 catastrophe to economists, except for the suggestion that chemical industry and its masters, together with other industries and their masters, may not have realized the inflection point in the curve and may have stubbornly tried to make production follow the curve, B, as shown in the figure. This break in the curve in 1929 shows again how dependent the future of chemistry is on factors beyond the control of chemists. Perhaps my analysis of this problem as shown by this curve is not correct, but I do believe that the method of approach is valuable. People working with the social sciences are apt to make the postulate that there are no laws of nature underlying these economic problems and that the only important factor is man's

wishes and desires. I believe that man's will in regard to these things is one factor in the problem, but that it is not by any means all of it. We can solve our economic problems of this kind when we approach them with the same point of view as that with which physical and biological science approach their problems. There are underlying natural laws behind the phenomena; with these laws we get the maximum good out of our efforts. If we attempt to superimpose false points of view on these natural phenomena, nature resists and our efforts bring us only the greatly decreased returns which the experimental data of this curve illustrate.

Because of the difficulties evident in this curve, as well as those that I have emphasized before in regard to the unpredictable desires of man, I can only express some hopes for the future for the industrial application of my science. I hope that in the near future the chemical production will fall on the curve, A, of Fig. 1, and that this will represent products designed for peace and not for war. It would appear that the future is able to bring better clothes for people from better cotton, silk, wool or linen or fibers better than these. These will be far more beautifully dyed than they are at the present time, and they will probably be produced with less effort than they have been in the past. The food of man will be produced in greater variety than at present. Fertilizers will make the arable areas of the earth produce a great abundance for the present populations of the earth and for even much greatly increased populations than now exist. The study of vitamins will mean that the foods will be better, more wholesome than they are at present. The dwellings of man in the future will be made of materials as yet unknown. They will be more durable, more beautiful and more easily constructed.

In addition to necessities, many luxuries will be supplied. Even if petroleum is exhausted liquid fuels will be made from materials grown on our farms. The automobile will continue with us and plane travel will still be possible so far as its fuel and lubrication is concerned. In addition to the preventive medicine which I have mentioned, in which we see to it that the proper vitamins, hormones and other necessary substances are supplied, internal medicines have been developed in the last few years which are very effective against many diseases. This development will certainly continue in the future. Since the beginning of the century many diseases have almost disappeared from civilized countries. Typhoid, for example, has largely been eliminated by adding small amounts of chlorine to drinking water. Chemistry will produce the anesthetics for surgery in the future, and disinfectants, as it has produced them in the past.

Finally, the greatly increased productive capacity which results from the use of chemistry and the other sciences must be expected to profoundly modify our social and economic institutions. This should be regarded as one of the great contributions which these things will bring to man.

My remarks at this point are not particularly original with me, nor can I prove them with the exact marshalling of data characteristic of my science. I think they are worth presenting, nevertheless. Sometimes it happens that the details of a complex set of phenomena can not be followed, but that general statements can be made about them without a knowledge of the details. The weather is a much-discussed subject, just as economics is. While we can not say precisely why the weather was hot and sultry last week, and it is cool and clear this week, we know that the general temperature is determined by the distance of the earth from the sun. Though spring may be early or late without any evident reason, we know that the changing seasons are caused by the inclinations of the earth's axis to the plane of the earth's orbit.

During the past century or so a science has developed which never existed before. Its application to industry by the various branches of engineering has proved most effective for the production of goods. These methods of production have the characteristic that they may be used to make goods cheaply in abundance but also to make them cheaply only if they are made in great quantities. The invention of limited liability corporations has proved to be the type of business organization necessary to carry out this production with the use of scientific methods. These things, together with an inadequate method for distributing the goods produced, are to my mind the underlying cause of most of the serious difficulties of this century. Probably the business rivalries which led to the world war, communism in Russia, the invasion of Manchuria and China and of Ethiopia and world-wide depression have all resulted from the great production of goods by scientific methods, together with archaic methods of distribution. If goods are to be produced in large quantities, they must be consumed in large quantities. Whatever that distributive system will be, it must distribute an abundance to many people and not to the privileged few only. If this is not done, we must abandon these mass production methods. I am optimistic enough to believe that we will accomplish this and that chemistry and her sister sciences will bring an abundant physical and intellectual wealth to our posterity; it will decrease labor and bring leisure, beauty and health. We solicit the help of the community to the end that we shall not always have the poor with us.

SCIENTIFIC EVENTS

APPROPRIATIONS OF THE BRITISH COLONIAL DEVELOPMENT FUND

THE British Colonial Development Advisory Committee, according to the London *Times,* has recommended appropriations from the funds at its disposal of £781,698. Plans for which assistance is recommended include the development and conservation of the water and forest resources of Tanganyika; the further development of water supplies in the Bechuanaland Protectorate and Swaziland; and the construction of a water supply system in Malta designed to increase the irrigated area by about 45 per cent. Anti-soil erosion measures bulk largely, particularly in proposals for reclamation and land drainage in the Machakos district in Kenya.

The *Times* states that the committee regards the tsetse fly problem as a matter of supreme importance to the British Empire. Two thirds of the total area of Tanganyika Territory are still infested with the fly, and the remaining third is threatened with rapid infestation. Huge areas in other African dependencies are similarly infested, the result being that pressure of human beings and stock on the fly-free areas constantly increases and brings with it dangers of over-grazing and consequent soil erosion. The Tsetse Research Department in Tanganyika is the central organization, and the work carried out there benefits all African territories affected by the fly. The committee has recommended a free grant to this organization of £207,974, spread over the next seven years.

Other grants are made for the development of peasant agriculture in the Leeward Islands; the recruitment of probationers for the Colonial Forest Service; and the improvement of transport and communications in various West Indian islands.

CONTROL OF EROSION IN NORTH CAROLINA

AN official statement given out by the Department of the Interior reports that out of the North Carolina Beach Erosion Control Project, now well under way with Emergency Relief Appropriation funds, an unusual and valuable possibility is being developed by the National Park Service. This is expected to have far-reaching effect in protecting the Atlantic Coast in the Cape Hatteras area from further depredations through storms.

The area embraced in the project is that section of the sea-coast lying south of the Virginia-North Carolina line and extending to Coracoke Inlet, comprising some 175 miles of ocean front. It entails the creation of protective foredunes and dune ranges over approximately 70 per cent. of the area. This will be followed by sand fixation through protective planting and reforestation, to correct the devastation that has been in progress for more than a century. The entire project is under the control of the National Park Service.

The area consists chiefly of a barrier spit between sound and ocean varying from several miles to a few hundred feet. It has been provided by Congress that ultimately this coast may be set aside as a national seashore recreational area, the first of its kind on the Atlantic coast. For this purpose the Cape Hatteras section was selected as one of the most promising for development, because of its nearly primitive character and its historic value. Before the national seashore can be established, however, the enabling legislation provides that the lands involved in the project must be donated to the Federal Government.

From the new nursery of the Park Service already have come thousands of seedlings to plant many acres on the beach. Since the spring planting additional thousands of seeds have been planted in the nursery and new beds are now being prepared for next fall. If the nursery is successful in providing seedlings for each planting, a considerable amount of money will be saved on the project. It is believed that seeds collected locally probably have a better chance to survive the exposure to which they are subjected than seeds purchased from other sources.

INTERNATIONAL TECHNICAL COMMISSION OF PHARMACOPOEIAL EXPERTS

AT the recent session of the Health Organization of the League of Nations a commission was appointed to carry on the work of the Brussels conference for the establishment of standards for potent medicines. The committee consists of: Dr. C. H. Hampshire, chairman, London; Professor H. Baggesgaard, Copenhagen; Professor V. E. Zunz, Brussels; Professor M. Tiffeneau, Paris; Professor R. Eder, Zurich; Professor L. van Itallie, Leyden; Professor E. Fullerton Cook, Philadelphia; a member of the Union of Soviet Socialist Republics.

The conference was the outgrowth of earlier efforts to establish an International Pharmacopoeia. In 1902 a group of pharmacists from Brussels, in the name of the Belgian Government, issued invitations to practically all nations of the world to participate in a conference for the purpose of establishing uniformity in the definition and strength of the more potent medicines in use throughout the world.

At that time, the Pharmacopoeia of the United States was officially represented by Dr. H. C. Wood, Sr., and by Dr. Frederick B. Power. The chairman of the committee of revision, Professor Joseph P. Remington, was at that time greatly interested in this

international movement and in a contribution to the conference urged the practical policy of establishing standards meeting the approval of the conference and offering these to the Pharmacopoeial Commissions throughout the world for voluntary adoption.

A second conference was called for 1914, but was postponed because of the world war. It was finally assembled at Brussels in 1925, with representatives from more than forty nations participating. Additional uniformity in standards and preparations was recommended at that time and the conference adjourned after passing recommendations that its work be taken over by the health organization of the League of Nations.

The establishment of a pharmacopoeial secretaryship, at the League, has been the basis for discussion for many years, but the actual establishment of the program has only now been completed. The chairman of the committee, Dr. Hampshire, is the secretary of the British Pharmacopoeial Commission, which has recently published the first supplement to the British Pharmacopoeia. This International Commission plans to compile a list of the more important medicines used throughout the world and invite the respective National Pharmacopoeial Commissions in various countries to prepare model monographs, which when finally approved will be presented to the Pharmacopoeial Commissions of the world with the hope that they may assist in bringing about greater uniformity.

It is hoped that the International Commission may also be able to compile the Pharmacopoeial literature of the world for the use of all Pharmacopoeial Commissions, thus avoiding the duplication of literature reviews by each nation.

CELEBRATION OF THE CENTENARY OF THE CELLULAR THEORY

THE Mexican Society of Natural History has appointed a committee to invite participation in the publication of a commemorative volume, which will celebrate the centenary of the foundation of the cellular theory by Schleiden and Schwann.

The president of the society, Dr. M. Martínez Báez, is chairman of the committee. Other members are Professor Enrique Beltrán, Dr. Alfonso Dampf and Ing. José R. Alcaraz. This committee has issued the following appeal:

The scientific world celebrates this year the centenary of the cellular theory which was founded by the German botanist Mathias Jacob Schleiden and by the zoologist Theodor Schwann a hundred years ago. To commemorate this event, which according to E. B. Wilson, the famous cytologist, has had the same far-reaching consequences as the theory of evolution, the Mexican Society of Natural History (Sociedad Mexicana de Historia Natural) resolved at their meeting, May 6, to publish a special volume which would contain papers relating to problems of the cellular theory and kindred subjects.

The undersigned committee respectfully submits the resolution to the learned sister societies of the world and begs to invite all biologists interested in the cellular theory to collaborate in the preparation of the volume. The paper which, according to the jury, is the outstanding contribution, will be awarded the Schleiden-Schwann medal of the Mexican Society of Natural History. The terms of the contest are given below. Every cytological paper is welcome, but only those which have a direct bearing on the theory will be judged.

The committee hopes that the publication of a commemorative volume, with contributions by scientists of many countries, will not only serve science, but establish also friendly relations with Mexico, where research in biology has found in the last years an enthusiastic support by government authorities. The committee would be pleased if scientific societies, academies, editors of scientific reviews, etc., would insert these lines in their editions and if scientists would call the attention of their learned friends to the planned publication.

TABLET IN HONOR OF W. J. S. LOCKYER AND NORMAN LOCKYER

A CORRESPONDENT of the London *Times* reports that a memorial to the late Dr. W. J. S. Lockyer, who was the director from 1920 to 1936 of the Norman Lockyer Observatory, was unveiled on July 16. Founded by the late Sir Norman Lockyer, the distinguished astronomer, who was long editor of *Nature,* and Sir Frances McClean as a private observatory twenty-six years ago, it has since been equipped and maintained entirely by private donations. The buildings have a commanding position on the top of Salcombe Hill, Sidmouth, and visitors had an opportunity to inspect different departments. The observatory is especially equipped with telescopes and cameras.

The memorial includes a panel containing a portrait of Dr. Lockyer, surrounded by smaller portraits of Lady Lockyer, Miss Lockyer and several friends who assisted in the administration and organization of the observatory during his period of office. Beneath the panel is a cabinet containing the insignia and other records of the life and work of Sir Norman Lockyer, who died in 1920, and was succeeded as director by Dr. Lockyer, his son.

The memorial was unveiled by Sir Francis McClean. Sir Robert Mond presided, and those present included Sir Richard Gregory, chairman of the council of the observatory; Lady Lockyer, honorary treasurer; Captain W. N. McClean, honorary secretary; Mrs. J. Lockyer, Dr. H. Spencer Jones, Astronomer Royal, and D. L. Edwards, director of the observatory.

In his address Sir Richard Gregory, who succeeded Sir Norman Lockyer as editor of *Nature,* said that it ought not to be too much to hope that an observatory

like that on Salcombe Hill, in which many notable contributions to progressive knowledge were being made, would not have to depend entirely upon the relatively small number of friends who had hitherto maintained it in its high position. Funds for scientific studies which led to industrial development were liberally provided in England, but a subject like astronomy, which had little direct relation to profitable industry, had to look for support to those who desired knowledge only for its own sake, whether or not it was of practical value.

It happened sometimes that such knowledge, obtained in the pure pursuit of scientific truth, was afterwards found to be of practical service. The most remarkable example of that kind was associated with the name of the founder of that observatory. When Sir Norman Lockyer discovered the element helium in the sun in 1868 no one dreamed that it would be produced daily in immense quantities, and would be used for the inflation of airships. Twenty-six years after its discovery in the sun it was found to exist in certain minerals in the earth, and after the Great War it was found to be contained in fair quantities in natural gases in some oil wells in the United States, which had practically the monopoly of the gas.

RECENT DEATHS AND MEMORIALS

DR. FREDERICK TILNEY, since 1914 professor of neurology and neuro-anatomy at the College of Physicians and Surgeons, Columbia University, died on August 7 at the age of sixty-three years.

DR. LAWRENCE F. FLICK, organizer of the Henry Phipps Institute of the University of Pennsylvania and influential in the founding of the National Tuberculosis Association, died on July 6 at the age of eighty-one years.

DR. HAROLD DICKINSON SENIOR, emeritus professor of anatomy and director of anatomical laboratories at New York University, died on August 6 at the age of sixty-seven years.

DR. LOUIS C. LOEWENSTEIN, consulting engineer, New York City, died on August 3 at the age of sixty-two years.

DR. LOUIS SHEPARD DE FOREST, practicing physician, who retired several years ago as a professor at the Yale University School of Medicine, died on August 4 at the age of eighty-one years.

ARLAND LEE MACKINNEY, in charge of forest management research at the Southern Forest Experiment Station of the U. S. Forest Service in New Orleans, was accidentally drowned on July 4. He was thirty-four years old.

E. M. NELSON, formerly president of the Quekett Microscopical Club and of the Royal Microscopical Society, an authority on microscopy and microscope construction, died on July 20 at the age of eighty-seven years.

THE centenary of the birth of Edward S. Morse, distinguished for his work in zoology and ethnology, the first professor of zoology at the University of Tokyo, was celebrated on June 25 at Tokyo under the joint auspices of the Tokyo Science Museum and the Society for Propagating Scientific Knowledge. Morse was president of the American Association for the Advancement of Science in 1886, and from 1880 to the time of his death was director of the Peabody Academy, Salem, Mass.

TRIBUTE was paid on July 22 to the memory of Charles Dawson, who, between the years 1911 and 1913, found portions of the fossil skull of Piltdown Man and in doing so discovered the remains of the earliest Englishman known. Sir Arthur Keith unveiled a monolith memorial in the grounds of Barkham Manor, Piltdown, to mark the spot on which the fossil was found. The memorial, erected by permission of David Kerr, the present owner of the manor, is of Yorkshire sandstone and stands about 5 feet in height. A large and representative company was present at the ceremony.

SCIENTIFIC NOTES AND NEWS

PROFESSOR THOMAS HUNT MORGAN, director of the Wm. G. Kerckhoff Laboratories of the California Institute of Technology, corresponding member of the Academy of Sciences, Paris, has been elected one of the twelve foreign associates of the academy.

THE Liebig Memorial Medal of the German Chemical Society has been awarded to Dr. Eduard Zintl, professor of chemistry at Darmstadt.

THE fifth award of the Dawson Williams Memorial Prize, which is given in recognition of work done in connection with pediatrics, has been made to Professor Leonard G. Parsons, professor of children's diseases at the University of Birmingham. It was presented to him at the Plymouth meeting of the British Medical Association on July 19. Professor Parsons delivered the Dawson Williams Memorial lecture, describing his work on the nutritional problems of childhood.

DR. I. W. MAGILL, senior anesthetist to the Westminster Hospital, London, has been awarded the triennial Hickman Medal, given for "original work of outstanding merit on anesthesia or in subjects directly connected therewith." The award is made by the

council of the Royal Society of Medicine on the recommendation of the Council of the Section of Anesthetics.

THE title of emeritus has been conferred by the University of London on Dr. J. F. Thorpe on his retirement from the university professorship of organic chemistry at the Royal College of Science; on Dr. J. C. Philip on his retirement from the university professorship of physical chemistry at the Royal College of Science, and on Professor J. T. MacGregor-Morris, on his retirement from the university professorship of electrical engineering at Queen Mary College.

DR. EDWIN E. HEIZER, of the Ohio State University, has been appointed head of the new department of dairy industry of the University of Wisconsin. In addition to his work at the university Dr. Heizer has been since 1934 dairy cattle breeding specialist for the Holstein-Friesian Association of America, and for the past several years has had charge of the genetic work for the American Guernsey Cattle Club.

DR. EDWIN C. JAHN, of the New York State College of Forestry at Syracuse University, has been appointed to succeed Dr. Floyd C. Peterson as professor in the pulp and paper department.

DR. KARL F. OERLEIN, general chairman of the Pennsylvania Junior Academy of Science and professor of physics at the State Teachers College, Indiana, Pa., has been appointed head of the department of science at the State Teachers College, California, Pa.

PROFESSOR J. E. PEARCE, chairman of the department of anthropology at the University of Texas, has become director of the Texas Memorial Museum. Dr. G. C. M. Engerrand, professor of anthropology, has been appointed to take his place as head of the department.

AT Cornell University, Dr. Lyman G. Parratt has been promoted from an instructorship to an assistant professorship in physics.

DR. EDWARD B. DOLL, for the past two years teaching assistant in electrical engineering at the California Institute of Technology, and Dr. Lester Tarnopol, for the past year assistant in metallurgy in charge of the x-ray laboratory of metallurgy at Harvard University, have been appointed assistant professors in the College of Engineering of the University of Kentucky.

W. C. KRATHWOHL, professor of mathematics at the Armour Institute of Technology, has been appointed director of the department of educational tests and measurements.

SIR ARTHUR OLVER, until recently animal husbandry expert, Imperial Council of Agricultural Research, India, has been appointed principal of the Royal (Dick) Veterinary College, Edinburgh, in succession to the late Principal Bradley.

DR. VICTOR G. HEISER, until his retirement in 1934 associate director of the International Health Division of the Rockefeller Foundation, has been appointed research director of the Committee on Healthful Working Conditions of the National Association of Manufacturers. A survey of plant conditions will be started at once and an information service will be provided for approximately 80,000 factories employing from twenty-five to two thousand workers. Dr. Donald M. Shafer, formerly connected with the medical department of the Standard Oil Company of New Jersey, will be Dr. Heiser's assistant.

DR. H. J. SHAUGHNESSY has resigned his position in the department of bacteriology and public health at the University of Colorado School of Medicine and Hospitals at Denver to resume his former place as chief of the Laboratory Service of the State Board of Health of Illinois after a year's leave of absence from the latter.

DR. FRITZ HAAS, formerly curator of the department of mollusks at the Senckenberg Museum in Frankfort-on-Main, has been appointed for a period of one year to the zoological staff of the Field Museum of Natural History, Chicago, as curator of lower invertebrates. Dr. Haas has come to America under the sponsorship of the Emergency Committee in Aid of Displaced German Scholars, of New York, the Jewish Welfare Fund, of Chicago, and the Field Museum of Natural History.

DR. DONALD T. RIES, son of Dr. Heinrich Ries, professor of geology at Cornell University, has been appointed park naturalist of the Illinois Starved Rock State Park. Under the sponsorship of the Illinois Natural History Survey, he will plan and conduct educational nature trips for visitors to the park. For the last year he has been working in the insect collections of the Illinois Natural History Survey at Urbana.

DR. LUIZ DE PIÑA has been appointed head of the Institute of Criminology of the Portuguese Government. The institute replaces the Department of Criminal Anthropology, which has been reorganized on scientific lines.

DAVID CLEGHORN THOMSON, formerly secretary to the Appeal Committee of the University of Oxford, has been appointed general secretary of the British Society for the Protection of Science and Learning, in succession to Walter Adams.

THE following grants have been made by the Committee on Scientific Research of the American Medical Association: to Dr. Robert R. Sealock, of the School of Medicine and Dentistry of the University of Rochester, to aid in further investigation of the relationship of the metabolism of the melanin pigment pre-

cursors to vitamin C requirements; to Dr. Charles O. Warren, Jr., of the department of physiology of the Cornell University Medical College, for his work on the metabolism of bone marrow, and to Dr. Samuel R. M. Reynolds, associate professor of physiology at the Long Island College of Medicine, to support investigations on the action of oestrin on visceral and somatic small blood vessels.

DR. DANIEL STARCH, consulting psychologist and director of the research department of the American Association of Advertising Agencies, delivered a series of eleven lectures on "Psychology for Living" during the week of July 11 to 16 at the Iowa State College.

DR. R. H. CARR, professor of agricultural chemistry at Purdue University, has been given a year's leave of absence and will spend the time in Australia, where he will carry on research on soils and on plant life. He will sail from San Francisco on August 16. Dr. Carr will represent the American Association for the Advancement of Science at the Canberra meeting of the Australian and New Zealand Association at Canberra, Australia, from January 11 to 18, 1939.

DR. HENRY FIELD, curator of physical anthropology at the Field Museum of Natural History, Chicago, left on July 5 for an extended visit to Europe, where he will attend scientific meetings in Copenhagen, London and Brussels.

DR. H. G. FERGUSON, of the U. S. Geological Survey, left Washington on July 15 for Nevada, where he will be engaged in a study of the geology and mineral resources of the Hawthorne and Tonopah quadrangles. Field investigations of granites and related rocks in Massachusetts have been started by Dr. L. W. Currier. This work is to be conducted in cooperation with the State of Massachusetts. Dr. T. B. Nolan recently left Washington to resume studies in the Eureka and other mining districts in Nevada. Field work in the San Juan region and in the Cripple Creek district, Colorado, in cooperation with the state, has been resumed by W. S. Burbank and A. Herbert Koschmann, respectively.

THE French Association for the Advancement of Science will meet at Arcachon from September 22 to 27 under the presidency of M. Guilliermond, member of the Institute of France and professor of botany at the Sorbonne.

THE Government of Victoria plans to submit legislation to prevent refugee doctors from Europe, of whom forty have lately arrived, from practising in Victoria. The state has a reciprocal agreement with Italy permitting doctors qualified and registered in Italy to practise in Victoria and *vice versa;* also similar arrangements with the United Kingdom, the value of which is undermined by the action of the British medical authorities in registering refugees after an emergency course of fifteen months in a British university, though not allowing them to practise in the United Kingdom. The legislation will permit refugee doctors to practise only on completion of a course of five years in Victoria or a reciprocating country, thus overcoming the emergency registrations in the United Kingdom.

IT was reported recently in the daily press that all Jewish doctors and dentists in Germany are excluded as of January 1 from "panel" practice under the Compulsory Insurance Law. As ordinary medical practice in Germany is almost entirely paid for by the government insurance association, the great majority of Jewish physicians and dentists will suffer a heavy loss. Some eight hundred Jewish doctors and dentists in Berlin are reported to be engaged, at least in part, in such panel practice. Various restrictions have been laid on them, but they have still been able to treat patients under the Compulsory Insurance Law. The ruling does not seriously affect well-known specialists, but is said to make practice almost out of the question for most Jewish physicians. A recent wireless dispatch from Bucharest reports that the Rumanian Minister of Public Works, Alexander Cuza, Jr., issued an order that all Jewish doctors employed by sickness insurance companies must immediately be replaced by doctors of the Rumanian race.

DISCUSSION

AN UNPUBLISHED MANUSCRIPT BY THE LATE BASHFORD DEAN

FROM a cupboard in one of the offices of the Department of Fishes in the American Museum of Natural History there has recently been routed out a considerable collection of articles published by Dr. Dean between 1908–1912, together with various notes and drawings belonging to him. To my personal knowledge these materials have not been examined in twenty years. In going through these papers in search of data bearing on the drawings of the embryos of *Chlamydoselachus* and *Cestracion* wherewith to complete the Dean Memorial Volume, I have found an unpublished note by Dr. Dean on a Japanese water snake. This note, which is dated January 20, 1909, had been packed away and forgotten.

In possible explanation of the losing of this little manuscript, the following facts may be set forth. Dr. Dean spent the winter of 1901–02 in Japan and brought back not only a splendid collection of zoological materials but a very large one of Japanese arms and armor. This collection of armor was first loaned

to the Metropolitan Museum of Art and later purchased for it. Dr. Dean began to catalogue the collection in 1903 and in 1906 he was made honorary curator of arms and armor in the art museum. From this date on, more and more of his time was spent in the study of medieval armor in the Metropolitan Museum.

In 1914 Dr. Dean became full curator of arms and armor in the art museum and retained only an honorary curatorship of fishes in the American Museum of Natural History. Somewhere in the years 1909 to 1914 the mass of personal materials—the little manuscript included—was packed away in the cupboard referred to and forgotten.

The note on this snake, published herein ten years after his death, illustrates Dr. Dean's wide interest in all living things and his keen powers of observation and interpretation. Dr. G. K. Noble has read the note, has corrected the nomenclature and has suggested publication.

E. W. GUDGER

NOTE ON THE SEA-SNAKE, PELAMAS PLATURUS (LINNAEUS) BY BASHFORD DEAN

THE zoologist has up to the present time given but little attention to the habits of sea-snakes (Hydrophiidae), in spite of their relative abundance and their wide distribution. He has long noted that they have become eel-like in their adaptation to purely aquatic conditions—every museum specimen tells him this—but he would none the less be surprised, I fancy, to see how utterly eel-like they have become when he observes them living.

In the aquaria at Misaki [Japan] I have kept at different times specimens of the striped *Pelamas platurus* (Linnaeus); they are curiously unsnake-like, constantly active and moving about with the least apparent effort, gliding through the water with fish-like rapidity. Their movements are obviously aided by an enlarged and flattened caudal "fin" and an outcropping ventral body wall, which serves as an anal fin. These snakes are, on the other hand, unsuited to living on land, and it is altogether improbable that they ever emerge from the waters. A specimen placed on the ground threshed vainly about like an eel—it progresses hardly more rapidly, for its vertically compressed body yields it no attachment for propulsion, and it lacks the supporting costal plates.

Numerous other adaptations to its complete aquatic life would, we might expect, be brought to light upon detailed observation. It may be worth while to record that on one of the specimens I secured the skin was notably "foul" and that young barnacles (Lepads of some species) were growing at various points, and that a large tuft of them was attached to the dorsal lobe of the tail. It was clear, accordingly, that the sea-snake had lost the ancient ophidian habit of cleaning its body surface by writhing through its coils, and it was quite possible that the period of skin-shedding was not as brief a one as in the case of its land-relatives—for in the present instance the tuft of barnacles measured nearly an inch in diameter.

This adaptation on the part of the sea-snake could easily give rise to more serious reflections. Is the fouling of the surface of the adapted form a harmful, harmless or useful character? It is harmful if it retards progression, injures the skin in the sense that it renders this organ the seat of attachment for disabling parasites of various kinds; harmless in the sense that the fouling of the cuticular surface affected only the tissue which was already in train to be sloughed off; useful if the green color of the fouled surface would make the snake inconspicuous to both enemy and prey, or if, by the fostering of edible growths, barnacles, hydroids, etc., it would provide a "bait" to various creatures upon which the snakes might feed. Each or all of these views could considerably be upheld by more or less serious people who have not the opportunity to observe and to experiment—witness the numerous and unconvincing discussions in adaptation, even during the past decade.

A TRIBUTE TO JOHN L. RIDGWAY

WHEN John Livzey Ridgway retired from active duty as scientific illustrator for the California Institute of Technology and the Carnegie Institution of Washington on July 31, 1938, there came to a close a long and distinguished career having few parallels among workers in the natural sciences.

Urged to go to Washington from his home in Illinois by his brother Robert, who later became the eminent authority in ornithology, John L. Ridgway as a lad was first employed to make scientific drawings at the Smithsonian Institution. His ability to draw birds with great accuracy was quickly apprehended, and it was not long before his talents were sought after in other fields of natural history. His first preceptor in drawing, the late William H. Holmes, encouraged him to take the Civil Service examination for the post of draughtsman in the U. S. Geological Survey. On passing this examination and receiving an appointment under Mr. Holmes, Ridgway found himself in a small company of young illustrators, several of whom, like H. Hobart Nichols and De Lancy W. Gill, were destined to become nationally known artists.

At that time the Geological Survey and Bureau of Ethnology were under the directorship of Major Powell, and Ridgway was therefore called upon to furnish drawings not only for geology and paleontology but also for ethnology and anthropology. Ridgway

later became head of the art department, the predecessor of what was then termed the Division of Illustrations of the Geological Survey, and in 1898 was appointed chief of that division. His association with the Survey continued for more than thirty years until his resignation and change of residence to California in 1920. During this long period of service countless drawings were products of his pen and brush. Ridgway's experience with the needs of authors led to the publication by the Survey of his pamphlet on the preparation of illustrations. This article received wide use and has been reprinted four times.

To pass in review the names of some authors whose contributions to science were materially aided and embellished by Ridgway's illustrations emphasizes the amazing productivity as well as versatility of this artist. His work included the execution of wash drawings of Mesozoic invertebrates for C. A. White, Cambrian fossils for C. D. Walcott, geological sections and paleontological materials for R. T. Hill, living reptiles for Shufeldt and Yarrow, fossil insects for Scudder, birds' eggs in natural color for the memoir by Bendire, fossil plants for White and for Knowlton, cephalopods for Alpheus Hyatt and later for J. P. Smith, ores and rocks in their natural colors for Van Hise and Leith, fossil crinoids for the well-known memoir by Wachsmuth and Springer, and in addition literally hundreds of pen and ink sketches on various subjects of which many have been reproduced in textbooks. It was during this period also that Ridgway was called upon for advice in matters of illustration by the newly established Carnegie Institution of Washington, and the high standards evolved in the handling of illustrative material by that institution were in a measure the result of his personal supervision.

To many men these accomplishments would have sufficed as a satisfactory life's work, but not long after his retirement to California, Ridgway was again busily engaged, at first with the Carnegie Institution and later with this institution and the California Institute of Technology, in supervising and making illustrations. During this additional period of eighteen years he was occupied for a time at Mt. Wilson Observatory, but the major part of his contributions were in vertebrate paleontology. The various paleontological papers and memoirs illustrated by him and published particularly by the Carnegie Institution give ample testimony of his skill and artistic ability. As a fulfillment of a wish and a remarkable accomplishment in itself, considering the fact that it was written by the artist late in life, is Ridgway's recently published work on "Scientific Illustration." This book, which contains a fund of information, marks a new departure in subject-matter and has received much favorable comment.

John L. Ridgway will long be remembered for his high standards in illustration. It is indeed a privilege and a pleasure to acknowledge the debt of gratitude which the natural sciences owe to this modest servant, who for more than half a century has labored to combine beauty with scientific accuracy in the delineation of fact.

CHESTER STOCK

CONTRIBUTION NO. 256
CALIFORNIA INSTITUTE OF TECHNOLOGY

EDITORIAL LICENSE

IN the May issue of the *Pan-American Geologist* there appeared a paper by the writer entitled "Outlines of Kentucky Geology," the first of a series of stratigraphic articles, the manuscript for which had been submitted two months earlier. These notes are written to call attention to an example of the misuse of the editorial prerogative. Certainly in the editing of any manuscript changes both in construction and content must be approved by the author under whose name it is printed and for the statements in which he takes responsibility. This along with the final check of the page proof is accepted practice and the author's right.

Yet in the matter of the paper referred to above the writer heard nothing from his manuscript until, quite unexpectedly, the first instalment appeared in print. Errors introduced include:

(a) Plate XX—Stratigraphic Chart
   1. To make space for rearranged column headings two explanatory notes were eliminated. These notes called attention to changes made in the interpretation of stratigraphic sections taken from the work of others.
   2. To help reduce it to page size the bottom of one section was cut off along with a part of a formational name. The Camp Nelson limestone became the "Nelson" limestone.

(b) (p. 283) The Mt. Hope and Fairmont formations were reinterpreted as the Mt. Hope and Fairmont facies. There is no justification for the use of the term facies for these faunal zones.

(c) (pp. 286, 287) The Arnheim formation was changed to the Arnheim member and the Sunset and Oregonia members of that formation continued as members of that "member."

(d) (p. 268) The Saint Peter sandstone was changed to "Peter sandstone."

(e) (Pl. XIX) In retouching the outline geologic map, weighting of the eastern state boundary has made the Pine Mountain fault appear to extend north of the Breaks of the Sandy.

(f) The term High Bridge is changed to Highbridge on page 269 and left as High Bridge on page 268. This is a matter of not misspelling but inconsistency.

(g) An occasional misspelled word which the author had no opportunity to correct in the galley proof.

(h) A tabular outline of formations which would have clarified the text was eliminated.

There are few manuscripts that may not be improved through proper editing, but the question is not one of the desirability or undesirability of any changes. It is one of responsibility on the part of the author for the contributions printed under his name and his right of approval of these changes before the article comes from the press. The editor has been notified that the manuscript is to be returned and that no further instalments be printed.

ARTHUR C. MCFARLAN
UNIVERSITY OF KENTUCKY

SOCIETIES AND MEETINGS

THE CONFERENCE ON ALGEBRA AT CHICAGO

THE intense current interest in algebraic research was exemplified in a conference on algebra at the University of Chicago from June 28 to July 1. It followed a conference at Notre Dame in February on the algebra of geometry and a symposium of the American Mathematical Society at Charlottesville, Virginia, in April on the "structure" or "lattice" theory of algebraic systems. The success of these meetings has demonstrated the effectiveness of mathematical conferences devoted to the study of a single topic.

The Chicago conference was concerned largely with linear algebras and algebraic geometry. It opened on Tuesday morning with an address by Professor L. E. Dickson, of the University of Chicago. He traced the history of quaternions and other linear algebras. Some of the rules of ordinary algebraic manipulation do not apply to these algebras; in particular, $xy = yx$ is not always true. However, the algebras still include "integral" elements with many of the properties of ordinary whole numbers. Professor Dickson described the long and difficult search for these numbers and their final discovery.

New and explicit formulas for sets of whole numbers in certain important algebras, the cyclic algebras, were presented by Professor R. Hull, of the University of Illinois. Professor C. G. Latimer, of the University of Kentucky, explained how the arithmetical properties of the integral sets in quaternion algebras are closely related to properties of quadratic and hermitian forms. These arithmetical properties depend on certain sets of elements, called ideals. Professor MacDuffee, of the University of Wisconsin, explained how many of the computations with such ideals could be carried out by the use of matrices.

A new and very general process for the reduction of hermitian and related types of matrices to canonical forms was outlined by Professor J. Williamson, of Johns Hopkins. Professor M. H. Ingraham, of the University of Wisconsin, explained how certain reductions to canonical forms can be simplified by replacing a matrix by a smaller matrix whose elements are themselves in a division algebra.

The algebras found by combining division algebras with algebras of all n-rowed square matrices were analyzed by Professor R. Brauer, of the University of Toronto. Professor A. A. Albert, of the University of Chicago, gave a new proof for some properties of the algebras built up by combinations of cyclic algebras. Cyclic algebras constructed from numbers with certain continuity properties were analyzed by Dr. O. F. G. Schilling, of Johns Hopkins. Certain related arithmetical devices were used by Professor Artin, of Notre Dame, for the solution of quadratic equations homogeneous in several variables.

Professor R. Baer, of the University of North Carolina, investigated the extent to which the structure of a commutative group is determined by the inter-relations of its subgroups. Dr. N. Jacobson, of the University of North Carolina, explained the structure of Lie algebras. One example of such algebras is furnished by ordinary vectors, using vector multiplication.

Considerable controversy attended the presentation of papers on Wednesday on curves and surfaces defined by algebraic equations. Professor S. Lefschetz, of Princeton, declared that many results in such geometry previously found by analytical methods could be obtained by simple algebraic devices. There was a lively discussion of the role of such methods. After the formulation by Dr. S. MacLane, of the University of Chicago, of certain algebraic tools which characterize the points on a curve, Professor O. Zariski, of Johns Hopkins, made elegant applications of such methods to the simplification of singular points of surfaces.

On the second day of the conference a dinner was held in Judson Court for visiting and local mathematicians. More than 140 enjoyed the dinner and the ensuing speeches. One speaker stated that over 90 graduate students are in residence at the university this summer.

The university's program of mathematics this summer emphasizes algebra. In addition to the regular courses, there is a seminar on algebra conducted by members of the staff.

S. MACLANE
G. B. PRICE

EIGHTH ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

THE eighth annual meeting of the Field Conference of Pennsylvania Geologists was held in Maryland, West Virginia and Virginia from May 27 to 30, inclusive. The total attendance of 96 members and guests included, besides Pennsylvanians, geologists from the U. S. Geological Survey, New York, New Jersey, Massachusetts, Delaware, Maryland, West Virginia and Virginia.

The conference hosts were the members of the Virginia Geological Survey. The 1938 committee consisted of Dr. Arthur B. Cleaves, *chairman;* Dr. Arthur Bevan, state geologist of Virginia, *local chairman;* Professors F. M. Swartz and R. E. Sherrill.

On Friday evening an assembly was held in Cumberland, Md., and details of the following day's stratigraphic trip explained by Dr. Frank M. Swartz.

On Saturday the entire conference participated in a field excursion covering strata ranging from Upper Cambrian to Upper Devonian, in the area lying between Cumberland, Md., Keyser, W. Va., and Winchester, Va. Drs. Frank M. Swartz and Charles Butts were the leaders.

The annual dinner was held at the George Washington Hotel in Winchester on Saturday evening. A welcome was extended to the conference by the president of the Winchester Chamber of Commerce. Other speakers were Dr. Arthur B. Cleaves, 1938 chairman, of the Pennsylvania Topographic and Geologic Survey; Dr. Arthur Bevan, local chairman, state geologist of Virginia; Dr. Charles Butts, of the Virginia Geological Survey; Dr. Frank M. Swartz, of Pennsylvania State College; Dr. Wm. M. McGill, assistant state geologist of Virginia, and Dr. Bradford Willard, of the Pennsylvania Topographic and Geologic Survey, who was the official representative of the conference at the International Geological Congress in Russia in 1937.

The field excursion on Sunday, led by Dr. Swartz and Dr. Butts, from Winchester to Luray, Va., covered strata from Upper Cambrian to Upper Devonian and included a study of the Massanutten Mountain syncline. In the evening a complimentary trip through Luray Caverns was enjoyed by the conference.

On Monday morning the party was led by Mr. George W. Stose, of the U. S. Geological Survey, from Luray to Panorama and Front Royal and studied the pre-Cambrian-Cambrian complex exposed on the north half of the Skyline Drive.

The conference as a whole disbanded at Front Royal on Monday noon, but a small group under the leadership of Dr. Arthur Bevan traveled to Leesburg, Va., and examined the Triassic beds exposed there.

The 1939 field conference will be held in West Virginia, where the West Virginia Geological Survey will be hosts. Members of the committee for the 1939 conference are: Dr. Paul Price, state geologist of West Virginia, *chairman;* Professor Benj. L. Miller, Department of Geology, Lehigh University; Professor R. E. Sherrill, Department of Geology, University of Pittsburgh, and Dr. Arthur B. Cleaves, secretary-treasurer, of the Pennsylvania Topographic and Geologic Survey.

The guide book for the 1938 conference was prepared in permanent form as a special bulletin of the Virginia Geological Survey. It is the first of a series planned by that state. It can be obtained from the state geologist of Virginia and the title is: Guidebook Field Conference of Pennsylvania Geologists, Virginia, 1938. Guide Leaflet No. 1.

ARTHUR B. CLEAVES,
Secretary.

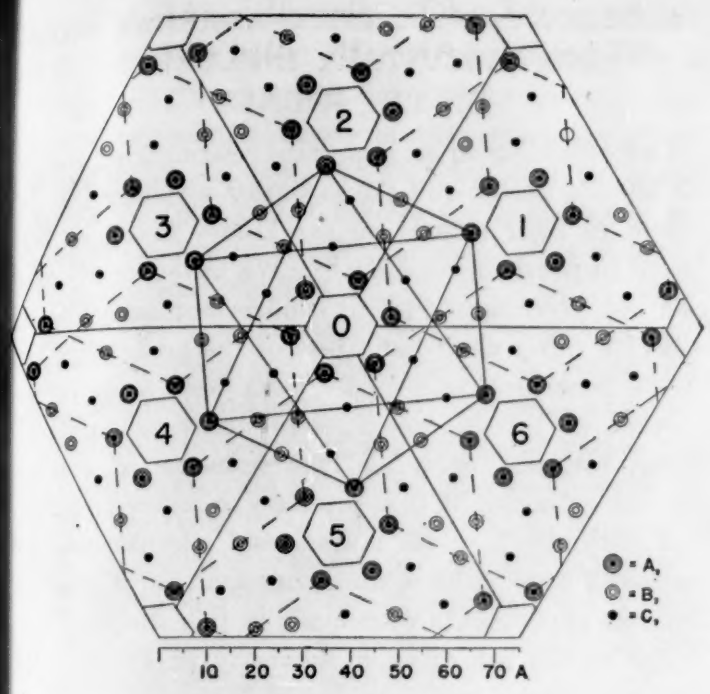
SPECIAL ARTICLES

THE STRUCTURE OF THE INSULIN MOLECULE

ON the basis of the Cyclol hypothesis,[1] a structure C_2 was proposed for the insulin molecule.[2, 3] C_2 is a cage structure consisting of a fabric carrying side chains, bent over a truncated tetrahedral framework.[2] The only metrical parameter, a (a mean between C–C and C–N bond lengths), taken[2] as 1.5 A, defines the dimensions of C_2. C_2 molecules with axes parallel fit the rhombohedral cell of the insulin lattice given by an x-ray analysis.[4] They can be arranged with any orientation α in the corresponding hexagonal cell, and α was necessarily left undetermined.[3] Further data, namely, Patterson-Harker diagrams, have now become available.[5]

It has been stated that these diagrams are incompatible with the structure I proposed for insulin.[5] I have therefore made a study of the Patterson-Harker diagrams given by C_2. The skeleton of C_2 is a truncated tetrahedron with six slits whose centers give an octahedron of side $l = 8\sqrt{6}a$. All the vectors between points on its framework lie on or within a truncated octahedron of side $2l = 16\sqrt{6}a = 58.8$ A. Postulating concentrations of atoms near these six octahedral

[1] Wrinch, *Nature,* 137: 411, 1936; *Proc. Roy. Soc.* (London), 160A: 59, 1937.
[2] Wrinch, *Nature,* 139: 972, 1937; *Proc. Roy. Soc.* (London), 161A: 505, 1937.
[3] Wrinch, SCIENCE, 85: 566, 1937; *Trans. Faraday Soc.,* 33: 1368, 1937.
[4] Crowfoot, *Nature,* 135: 591, 1935.
[5] Crowfoot, *Proc. Roy. Soc.* (London), 164A, 580, 1938.



points of the C_2 we obtain Patterson-Harker peaks for a molecule at 0 which lie at the corners and midpoints of the sides of the octahedron $2l$ with center at 0. The figure shows the projection on the c-plane of these 18 peaks giving a hexagon with center at 0, with side length 33.9 A. There are six at its corners, six at the midpoints of its sides and six at the midpoints of lines joining alternate corners; indicated for convenience as A, B and C, respectively.

We now notice that Crowfoot's c-plane projection also gives 18 peaks per molecule, reproduced in Fig. 1, which fall into a pleasing pattern of hexad, triad and dyad sets. Superposing the C_2 hexagon on this diagram, we turn this hexagon about its center, through an increasing angle α until any of its points falls upon a Crowfoot peak. We find with $\alpha = 6°$ that all A peaks fit on A peaks, B peaks on B peaks and C peaks on C peaks, as shown in Fig. 1.

This procedure allocates to the molecule at 0 one A peak in each of the hexad sets surrounding the points 1,2,3,4,5,6; the most remote B peak of each neighboring triad set; the near C peak of each neighboring dyad set. Drawing corresponding hexagons around other molecules all the A, B and C peaks are filled in. The six nearest A and B peaks around O are contributed, one each, by the molecules associated with the positions 1,2,3,4,5,6, and none of them by the molecule at 0.

So far the details of the skeleton and the positions of the side chains attached to the C_2 molecules have been left out of account. Nevertheless, the 18 peaks per molecule in Crowfoot's c-plane projection are given in the correct positions, on the assumption that there are concentrations of atoms at the six slits.

The full investigations will shortly be published. They show the direct relation between the diagrams obtained from the C_2 structure and all the diagrams given by Crowfoot and include also an account of the geometric method of interpreting Patterson-Harker diagrams in general, both for molecules and for mega-molecules.

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l-GLYCERIC ALDEHYDE AND TUMOR METABOLISM

IT was reported some years ago that dl-glyceric aldehyde inhibits glycolysis of tumor cells.[1] Under *anaerobic* conditions glycolysis is inhibited about 75 per cent. by 10^{-3} M. and almost completely stopped by 1.5×10^{-3} M. This applies to all malignant tumors, *i.e.*, to human and animal tumors, to spontaneous tumors and tumors transplanted or produced by carcinogenic substances, to sarcoma as well as to carcinoma, whether filterable or non-filterable. The *aerobic* glycolysis of tumors is less sensitive to glyceric aldehyde; 4×10^{-3} M. are required for an inhibition of about 75 per cent.

Some months ago J. Needham and H. Lehmann[2] found that d-glyceric aldehyde does not affect glycolysis of embryos. Nor does it inhibit glycolysis of tumors, as we have shown in a previous communication.[3] The effect of dl-glyceric aldehyde thus seems to be due to the l-form, and therefore it was of interest to examine the action of this isomeride.

H. O. L. Fischer and E. Baer recently succeeded in preparing pure l-glyceric aldehyde.[4] With this substance experiments were carried out on tumor slices, and it was found that l-glyceric aldehyde is about twice as effective as the racemic form. A slight inhibition (about 25 per cent.) of the anaerobic glycolysis of tumors is obtained with concentrations as low as 3×10^{-4} M., glycolysis is inhibited about 75 per cent. by 5×10^{-4} M. l-glyceric aldehyde, and almost completely stopped by 7.5×10^{-4} M. (see Table 1).

TABLE 1
ANAEROBIC GLYCOLYSIS OF RAT SARCOMA 39

l-Glyceric Aldehyde M/litre	N_2 O_2 CO_2 (second half hour)
.....	37.7
3×10^{-4}	27.2
5×10^{-4}	8.8
7.5×10^{-4}	3.7

Under aerobic conditions 2×10^{-3} M. l-glyceric aldehyde inhibits glycolysis about 75 per cent.

[1] B. Mendel, *Klin. Woch.*, 8: 169, 1929.
[2] J. Needham and H. Lehmann, *Biochem. Jour.*, 31: 1913, 1937.
[3] B. Mendel, F. Strelitz and D. Mundell, *Nature*, 141: 288, 1938.
[4] E. Baer and H. O. L. Fischer, SCIENCE, July 29, p. 108.

The rotation of an aqueous solution of l-glyceric aldehyde, if kept in the ice-box, changes in a week's time from $[\alpha]_D^{20°} - 14$ to about -7. Dr. Baer has been able to restore the original optical activity of such a solution by evaporating it and heating the residue to 55–60° C. *in vacuo* for 2 hours. We found that the decrease in optical rotation is not accompanied by any noticeable change in the biological activity: both solutions whether $[\alpha]_D^{20°}$ was -7 or -14 were found to inhibit glycolysis to the same degree when used in equal concentrations.

As dl-glyceric aldehyde (0.5×10^{-2} M.) is known to inhibit respiration of brain cells, experiments were carried out to decide whether this effect is due to the l- or to the d-component. It was found that the inhibition is brought about mainly by l-glyceric aldehyde, whereas the d-form has only a slight effect on respiration. (See figure).

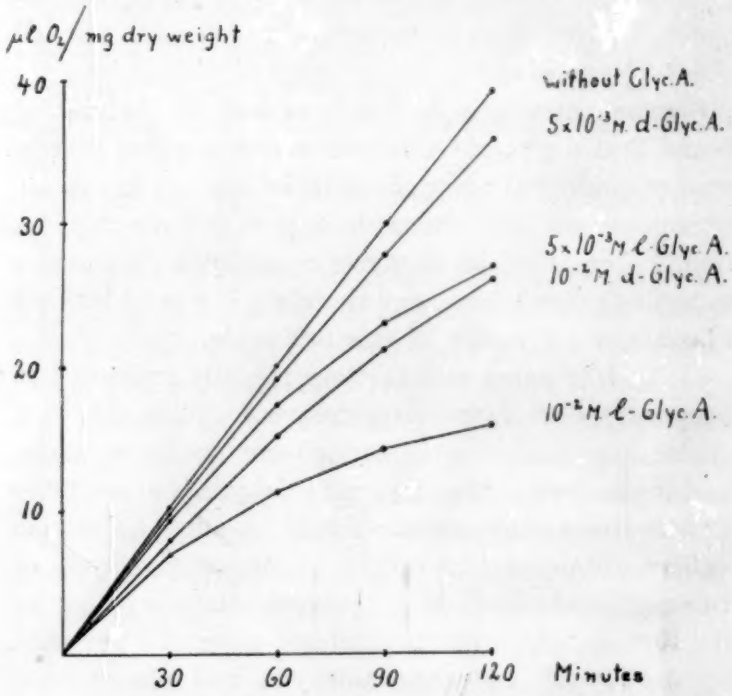

FIG. 1. Effect of d- and l-glyceric aldehyde on respiration of rat brain (grey matter) Ringer Phosphate, pH = 7.4.

The respiration of tumors is less sensitive to glyceric aldehyde than the respiration of brain, and the differences between the two optical forms were found to be less marked in experiments on sarcoma 39.

d- and l-glyceric aldehyde are fermented at the same velocity by slices of rat liver under anaerobic conditions.

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A THEORY OF CORTICO-ADRENAL AND POST-PITUITARY INFLUENCE ON THE KIDNEY

THE possibility of an important relationship between the adrenal cortex and the posterior pituitary lobe in regard to their actions on the kidney has been discussed in previous papers.[1,2,3] We have recently carried out experiments which confirm our earlier work and give fairly clear indication of the mode of action of the hormones concerned. Tests were made of responses of female opossums to orally administered water, salt and urea, and the influence of cortico-adrenal extract and post-pituitary solution (Squibb) was determined. Both normal and adrenalectomized opossums were utilized, and more than three hundred separate experiments were made in this study.

The results are given in summary in Table 1. It will be observed that in every case the action of cortico-adrenal extract on chloride excretion (per cc of urine) by the kidney is the direct opposite of that of the post-pituitary effect. Further, in every case the elimination of water under the influence of adrenal extract is greater than that under post-pituitary solution. It would appear that the latter hormone acts to bring

TABLE 1

EFFECT OF CORTICO-ADRENAL EXTRACT AND POST-PITUITARY SOLUTION (SQUIBB) ON RENAL SECRETION

Fluid administered†	Hormone administered	Normal opossums			Adrenalectomized opossums		
		Average water output, cc.*	Concentration in mgm./cc.		Average water output, cc.*	Concentration in mgm./cc.	
			Chlorides	Urea		Chlorides	Urea
Water	none	16.4	0.21	4.51	8.1	0.32	6.66
	cortico-adrenal extract	17.6	0.32	3.58	16.9	0.30	4.91
	post-pituitary solution	5.7	6.50	18.2	3.0	1.72	25.0
NaCl (0.9 %)	none	13.2	7.12	6.51	5.2	7.50	10.2
	cortico-adrenal extract	22.0	6.37	4.18	12.2	4.58	7.60
	post-pituitary solution	17.0	10.0	6.77	8.8	11.1	10.3
NaCl (0.9 %) plus Urea (2 %)	none	10.0	7.60	40.6	8.8	4.20	38.6
	cortico-adrenal extract	15.2	6.31	27.2	13.3	3.31	33.3
	post-pituitary solution	14.8	8.51	26.5	...	...	...

† 20 cc./kilo body weight/2 hours.
* Each figure represents an average of 12–21 metabolic runs. Water excretion on basis of cc/kilo body weight/2 hours.

1 H. Silvette, *Am. Jour. Physiol.*, 117: 405, 1937.
2 H. Silvette and S. W. Britton, *Am. Jour. Physiol.*, 121: 528, 1938.
3 H. Silvette, *Proc. Am. Physiol. Soc.*, fiftieth annual meeting, Baltimore, 1938, p. 188.

about a highly concentrated urinary output, containing large amounts of both chlorides and urea, while the hormone of the adrenal cortex induces a large urinary volume having a relatively low concentration of urea and chlorides. It is noteworthy, too, that the concentrations of both urea and chlorides in the urine tend to vary together, in one direction or the other, according to the hormone used.

A true diuretic substance is said to be one which will "consistently and reproducibly elevate the urine flow, as determined by catheterized specimens in well-controlled experiments, from moderate rather than very low levels; the diuresis should reach a rate at least comparable to that observed after a moderate dose of water, and it should persist for a period of at least 30 minutes."[4] In our experiments the hormone of the adrenal cortex as a diuretic factor fulfils these conditions in every respect.

The hypothesis that the cortico-adrenal hormone acts as a diuretic agent and in antagonism to the antidiuretic hormone of the posterior lobe of the pituitary explains the puzzling fact that hypophysectomized animals show only a transient polyuria, while animals from which the posterior lobe alone is removed show a persistent diuresis. When the posterior lobe only is excised, lack of its antidiuretic hormone plus the presence of the diuretic adrenal hormone would lead to polyuria through decreased water reabsorption from the renal tubules. When both lobes are removed, the uncompensated activity of the diuretic cortico-adrenal hormone would persist until the adrenal cortex (in the absence of the corticoadrenotropic hormone of the anterior lobe) becomes atrophic, at which time both posterior-lobe antidiuretic hormone and cortico-adrenal diuretic hormone would be absent from the bloodstream and polyuria would disappear.

From many considerations, now omitted for lack of space, it appears that while post-pituitary action may be exerted chiefly in the direction of inhibition of the aqueous portion of urinary excretion by the kidney, the influence of cortico-adrenal extract (in so far as its renal action is concerned) is directed towards increased water elimination. Thus the present experiments seem to establish the physiological antagonism of the post-pituitary and cortico-adrenal principles in their action on urinary secretion.

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[4] H. W. Smith, "The Physiology of the Kidney," New York, 1937, p. 229.

ISOLATION OF THE FUNGUS CAUSING THE RED STELE OR RED CORE DISEASE OF STRAWBERRIES

A SERIOUS root rot of the strawberry was described in Scotland in 1926, under the name "Lanarkshire disease."[1] The term "red core root" was proposed for the disease in 1929,[2] as being descriptive of its most characteristic symptom. A disease presumably identical with "red core root" was first reported in the United States in 1935 from Illinois, under the name "black-stele root rot."[3] In 1937[4] the "black stele" or "red stele" disease was reported from Virginia, Maryland, New Jersey, New York and Michigan, in addition to Illinois. This disease now appears to be spreading in the Middle Atlantic States and is becoming decidedly injurious in restricted areas where soil and climate are favorable to its development.

The red-stele disease may be easily distinguished from other strawberry root rots by the fact that the causal organism, while completely destroying fine, fibrous roots, advances up the central cylinders of larger roots, killing the interiors and causing them to turn dark red, while the surrounding cortex still appears alive and healthy. The fungus eventually advances to the stem of the plant, but apparently does not invade it. The larger roots die gradually, beginning at the distal ends, some time after the steles have been killed. As a consequence of the injury to the root system, affected plants wilt, older leaves die, and newly formed leaves remain very small with conspicuously short petioles. Badly diseased plants often succumb during the heat of spring and summer, but lightly affected plants grow normally through the summer, only to suffer a renewed attack by the fungus late in the season.

Red stele was first attributed to such causes as poor cultural conditions and parasitism by mycorrhizal fungi and by Pythium species. Since 1929[5] there appears to have been general agreement that the disease is caused by an undetermined species of Phytophthora. Oospores of the Phytophthora type occur commonly and abundantly in diseased roots, and sporangia and zoospores characteristic of the species may be induced by submerging recently infected young fibrous roots in cool water for a period of 18 hours

[1] Claude W. Wardlaw, "Lanarkshire Strawberry Disease, a Report for the Use of Growers (with preface by Professor J. M. F. Drummond)". Carluke (Scot.). Printed by J. Bell, 1926. Issued by Botany Department, University of Glasgow.

[2] Nora L. Alcock, Gard. Chron., 3 (86): 14–15, illus., 1929.

[3] H. W. Anderson, *Phytopathology*, 25: 5, 1935.

[4] J. B. Demaree and G. M. Darrow, U. S. D. A. *Plant Dis. Rptr.*, 21 (22): 394–399, December 1, 1937.

[5] Nora L. Alcock, *op. cit.*

or more. However, a survey of the literature discloses that previous attempts to isolate the fungus and grow it in pure culture have been unsuccessful. In the absence of pure cultures of the organism, it has necessarily been impossible to prove conclusively that the associated Phytophthora causes the disease.

The present note reports successful isolation of the Phytophthora from strawberry roots, proof of its pathogenicity, and some comments on its behavior in culture.

The fungus was isolated in November, 1937, from roots of diseased strawberry plants growing on the U. S. Horticultural Station farm at Beltsville, Md. Fall roots were well developed at the time, and the fungus was actively attacking the distal fibrous roots and had advanced a short distance up the steles of some of the main roots. Large roots with diseased steles but healthy cortex were thoroughly washed in sterile water, the cortex was carefully removed under aseptic conditions, and the upper 2 cm of the diseased zones were cut in pieces about 5 mm long. The pieces were mounted in a hardened drop of water agar on a coverglass, covered with an additional drop of agar, and inverted over a Van Tieghem cell. Growth of hyphae was followed under the microscope, and either developing hyphae or the entire root pieces, whichever seemed advisable from appearances, were transferred to test-tubes. Approximately 50 per cent. of the pieces yielded Phytophthora in pure culture, or contaminated only with bacteria, which were later eliminated from the cultures. A similar series of isolations from diseased plants collected by Dr. H. W. Anderson near Vermilion, Ill., late in March, 1938, yielded only 4 cultures of Phytophthora out of 45 isolations, most of the others giving a species of Pythium which evidently follows the Phytophthora very closely in the roots.

Pathogenicity was proved by inoculating mycelial cultures and zoospores to roots of potted strawberry plants which had been previously rooted from runners in autoclaved soil. Zoospore inoculation proved to be the simplest method. Abundant infection and some oospore production in fine roots was present six days after inoculation. Under greenhouse conditions wilting began three weeks after inoculation, and at this time the root systems were almost completely destroyed, showing all the characteristic symptoms of naturally infected plants. The organism was recovered in pure culture from inoculated plants by the method used in the original isolations, from the reddened steles of affected larger roots. Uninoculated check plants remained healthy.

The identity of the species is still being investigated. As had previously been determined[6] on its host plant, the fungus belongs to the group of Phytophthoras having large, non-papillate sporangia, comparatively large oospores and predominatingly amphigenous antheridia; but cultural and cross-inoculation studies have so far failed to place it accurately in any described species.

In culture, the Phytophthora grows best on oatmeal agar and in canned pea broth,[7] and somewhat less rapidly on lima-bean agar. Growth is unsatisfactory on all other media tried, including cornmeal agar. Neither sporangia nor oospores have occurred in the culture media tested up to the present time, but sporangia and zoospores develop in abundance when small blocks of mycelium, grown in thin layers of lima-bean agar, are shallowly irrigated with cool tap water. The fungus has a relatively low temperature range, mycelium being killed in one week at 30° C., while zoospores are produced at 10° C., but are inhibited at 22° C., the range of maximum production lying between 14° and 18° C. It is perhaps needless to point out that, together with mechanical distribution of diseased plant parts, zoospore dispersal constitutes the principal means of spreading the disease in the field.

Spore and sporangial measurements of the American red-stele organism come well within the range described for the Phytophthora associated with the Lanarkshire disease in Scotland, and since the symptoms are also similar in most respects, it appears probable that the two diseases are identical.

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[6] Ibid.

[7] L. H. Leonian, *W. Va. Agr. Exp. Sta. Bull.*, 262 (p. 13), 36 pp., 1934.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE MEASUREMENT OF THE EXTERNAL FORCE IN WALKING

FOR an adequate study of human locomotion it is necessary to measure with considerable precision the force exerted on the substratum by the foot at each instant during progression. Since this force is the resultant of the force of gravity and the reaction to the acceleration of the body at the moment, its measurement provides a means of determining the acceleration and so of the force concerned in the movement of the body as a whole. Three measurements are necessary if the force is to be known both as to magnitude and

direction. This can best be accomplished by measuring the force in three constant directions, in practise the three axes of rectangular coordinates.

In order to know the torque with which this force acts on the body, it is necessary, in addition, to know the position of the force. Since the horizontal components are situated in the plane of the platform upon which the subject walks, it is only necessary to determine the position of the vertical component in the horizontal plane to effect a complete determination of the force. This position was determined by Elftman and Manter[1] from cinematic records of the distribution of pressure in the sole of the foot, but it can be more easily achieved with the apparatus here described.

The base of the apparatus is so arranged that it can be suspended between two tables. Resting on this base are four vertical compression springs, supporting the lower of two platforms. When a force is exerted on the platform at any point the total compression in the springs measures the vertical component of the force. The relative distribution of this force between the springs depends on the position of the vertical component with respect to the plane of the platform. The quantities to be measured are three in number; it is most convenient to use the vertical displacement of the platform at points 1, 2 and 3 of the diagram. If the displacement is calibrated in terms of the force required to produce it, the sum of the displacements at points 1 and 3 will give the total vertical force and the position of this force can be obtained by equating moments. Although designed for the investigation of movement, this apparatus can also be used for the more traditional measurement of the position of the center of gravity when the body is stationary.

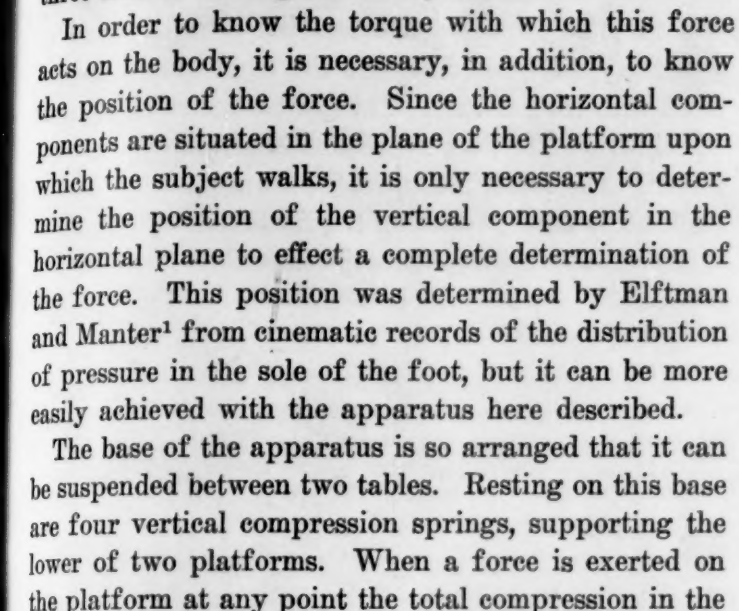

FIG. 1

The horizontal components of force may be measured by means of the displacement of the lower platform in the horizontal plane, since this depends on bending of the springs with respect to their vertical axes. This was proven to be a reliable method by Manter in his investigations on feline locomotion in this laboratory. With the human subject it has been preferable to measure the horizontal components by means of a second platform, parallel to the lower one but separated from it by ball bearings and attached to horizontal springs. From the displacement of the upper platform the components of the force in the direction of movement and lateral to it can be obtained.

The problem of recording the five displacements may be met in various ways. For walking it has been adequately accomplished by lever systems so arranged that the displacements are magnified without distortion and produce movements of indicating levers, all five of which are located in one plane. The indicating levers are photographed with a high-speed cine-camera, the actual speed of which is calculated from the oscillations of a pendulum placed in the photographic field. This camera also provides a record of the position of the foot. For analysis of locomotion another camera is used simultaneously to record the position of the entire individual, walking behind a rectangular grid.

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[1] H. Elftman and J. Manter, SCIENCE, 80: 484, 1934.

A PHOTOELECTRIC COLORIMETER

THIS apparatus is the result of an attempt to construct a photoelectric colorimeter which is relatively inexpensive but both highly accurate and sensitive. Many of the colorimeters available measure the current produced by a single photoelectric cell, a procedure which requires a constant light source, the constancy of which is maintained by variable resistances in the lamp circuit,[1,2] by a trickle charger on to a storage battery,[3] or by a diaphragm placed between the lamp and absorption cell.[4] Some of the difficulties with this method of employing a single cell arise from the variations in the current produced by the cell caused by fatigue and changing temperature. These difficulties can be avoided or minimized by using a variable resistance and a galvanometer as a null point indicator to balance the output of two photoelectric cells connected in opposition.[5] Goudsmit and Summerson[6] employed a balanced circuit, but effected the balance by changing the thickness of the layer of solution through which one of the beams of light passed.

[1] A. Weil, SCIENCE, 79: 593, 1934.
[2] K. A. Evelyn and A. J. Cipriani, *Jour. Biol. Chem.*, 117: 365–369, 1937.
[3] I. M. Diller, *Jour. Biol. Chem.*, 115: 315–322, 1936.
[4] C. Sheard and N. H. Sandford, *Jour. Lab. and Clin. Med.*, 14: 558–574, 1929; 15: 483–489, 1930; *Am. Jour. Clin. Path.*, 3: 405–420, 1933.
[5] H. Hartmann, *Ergeb. d. Physiol.*, 39: 412–449, 1937.
[6] A. Goudsmit, Jr., and W. H. Summerson, *Jour. Biol. Chem.*, 111: 421–433, 1935.

The instrument herein described utilizes a balanced circuit, but the balance is achieved by the use of a variable resistance in circuit of one of the photoelectric cells. The apparatus consists of a Leeds and Northrup 2420-c galvanometer, the light of which has been replaced by a 21 c-p. headlight bulb supplied with a 7-volt current from a transformer fed by ordinary house current (110 volts, alternating current). One photoelectric cell (General Electric, Cat. No. 4120833 G 1) is fastened to each side of the galvanometer box after a small window has been cut to allow the passage of light. Interposed between the lamp and the photoelectric cells are 2-inch square light filters, selected from molded filters of Corning Glass Works to transmit only light of the wave-length absorbed by the substance being analyzed, and absorption cells made by drilling a ¾-inch hole in a 1-inch Lucite block (du Pont). The filters, absorption cells and photoelectric cells are shielded to exclude all light save that coming from the lamp. The photoelectric cells are connected in opposition with a decade resistance (Leeds and Northrup, Cat. No. 3976) in the circuit to reduce the output of the left photoelectric cell. The apparatus is illustrated in Fig. 1. The materials and parts cost about one hundred dollars.

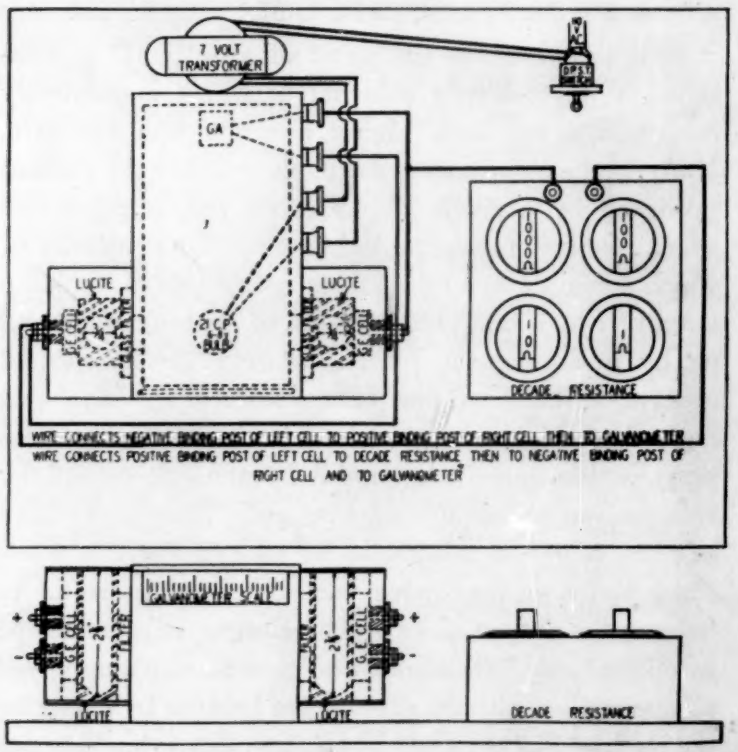
7 VOLT TRANSFORMER
GA
LUCITE
LUCITE
DECADE RESISTANCE
WIRE CONNECTS NEGATIVE BINDING POST OF LEFT CELL TO POSITIVE BINDING POST OF RIGHT CELL THEN TO GALVANOMETER
WIRE CONNECTS POSITIVE BINDING POST OF LEFT CELL TO DECADE RESISTANCE THEN TO NEGATIVE BINDING POST OF RIGHT CELL AND TO GALVANOMETER
GALVANOMETER SCALE
LUCITE
LUCITE
DECADE RESISTANCE

FIG. 1. Schematic drawing of photoelectric colorimeter. Upper drawing—vertical view. Lower drawing—frontal view.

The colorimeter has been employed so far only in the determintion of creatinine concentrations, using the alkaline picrate method. For this Corning filters No. 428 were used. The alkaline picrate diluted 1:2 with water is placed in both the right and left absorption cells and the galvanometer balanced, the reading in ohms representing the blank. After this blank determination the fluid is removed from the right cell by suction. To 20 cc of a creatinine solution 10 cc of alkaline picrate is added and the right absorption cell filled with the mixture. The galvanometer is balanced 12 minutes after the creatinine and alkaline picrate are mixed. The blank is subtracted from this reading. A calibration curve, based on triplicate determinations of dilute creatinine solutions, is shown in Fig. 2. The

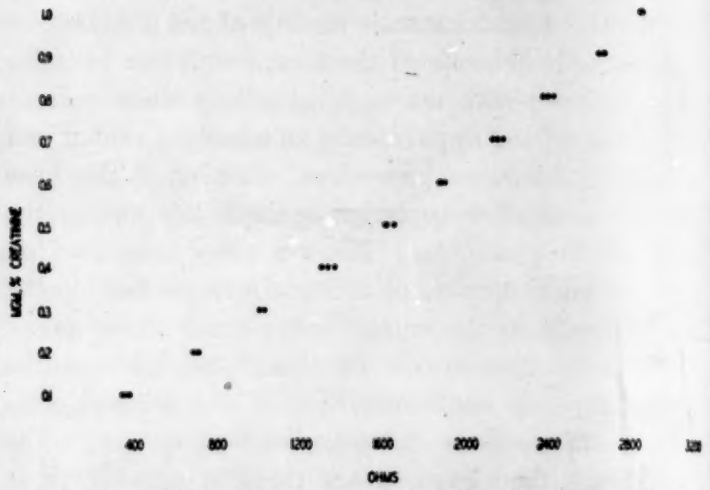

FIG. 2. Calibration curve of determinations of creatinine concentrations with photoelectric colorimeter.

instrument is most accurate in determining low concentrations.

A filter may be substituted for the left absorption cell and a receptacle containing a test-tube used in place of the Lucite cell on the right. The Lucite cells have given more accurate results and, while test-tubes can be used more conveniently, we have preferred to retain the more accurate and slower method.

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